Data and Decision Analytics

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OSD Case # 15-S-1708

Data Analytics Assessment Overview

Problem: There is currently no standard way to implement and assess performance for data analytics

- **Heterogeneous data sources/algorithms without ground truth**
- **Hard to know what capability is being purchased with few means to assess performance of service**
- **Dynamic mission space with changing requirements**

Solution: Data analytics framework

- **Standard data models with ground truth**
- **Development framework to standardize risk analytics on information sources, algorithms, and processing**
- **Adaptable framework that can change as mission requirements change**

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D2D/Data Analytics Approach

Analyst oversees delivery of information products to customer with rigorous quality of service guarantees

Current Approach

Sensor

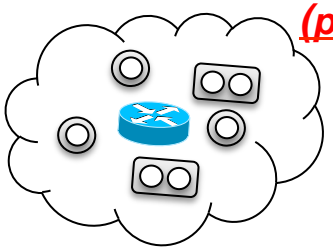
ISR/Text Data

Analyst

Cloud

User

(performance?)



New Approach

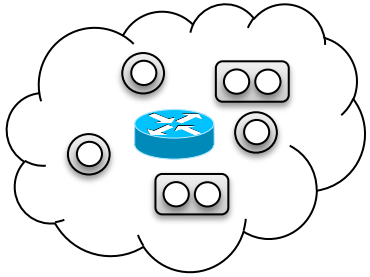
Analyst

Sensors/ISR/ Text/Data

(metrics)

Analysis Infrastructure

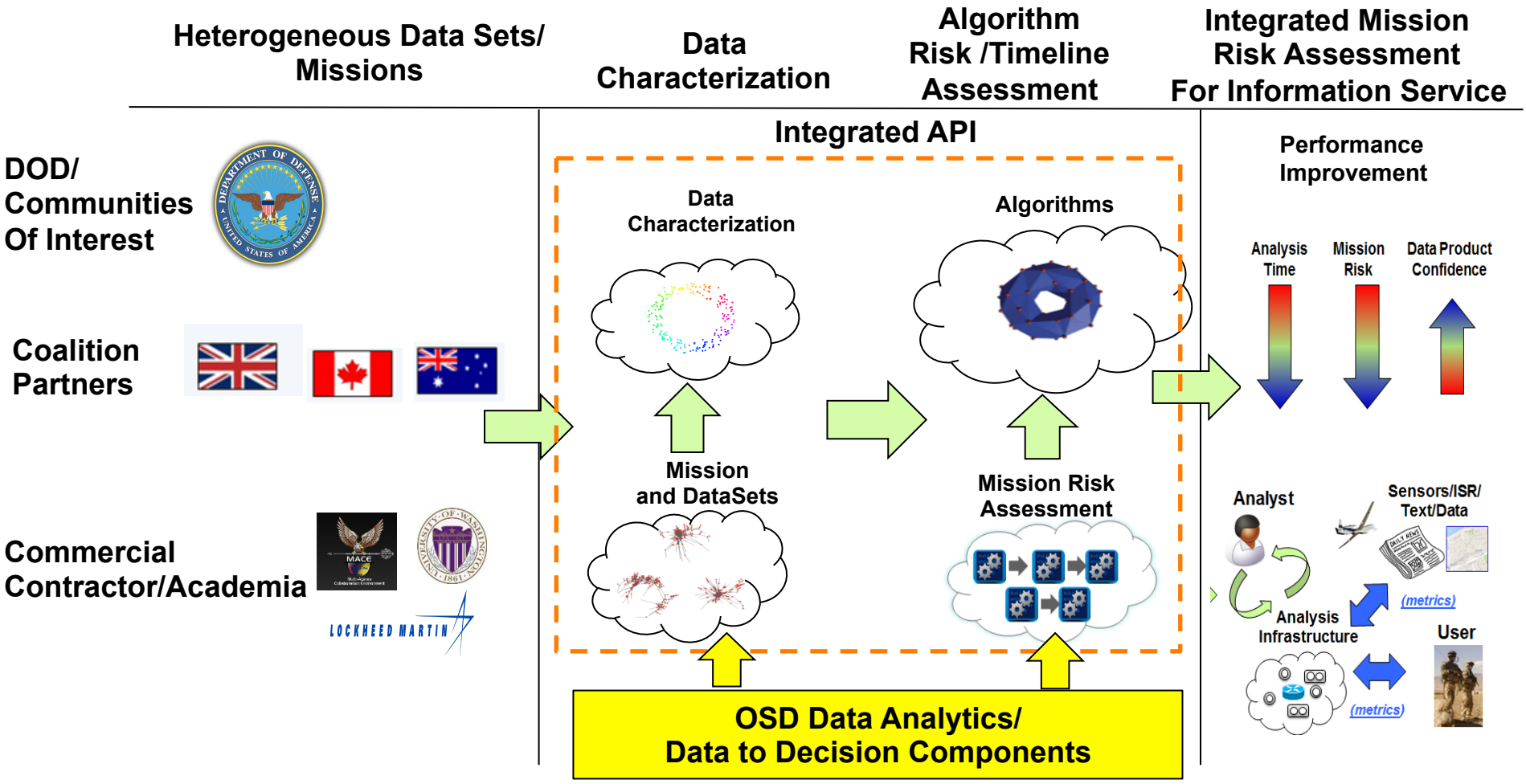
User



(metrics)

Data Analytics Performance Assessment

Implementation and assessment of information service can be standardized to assess overall mission performance



Components Can Assess Multiple Mission Types

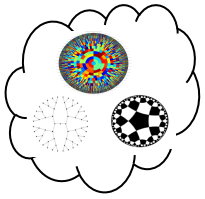
Incorporate a cloud based open standard for information services development and assessment so basic components can be used assess multiple types of missions

Data Analytics/ Data to Decision Elements

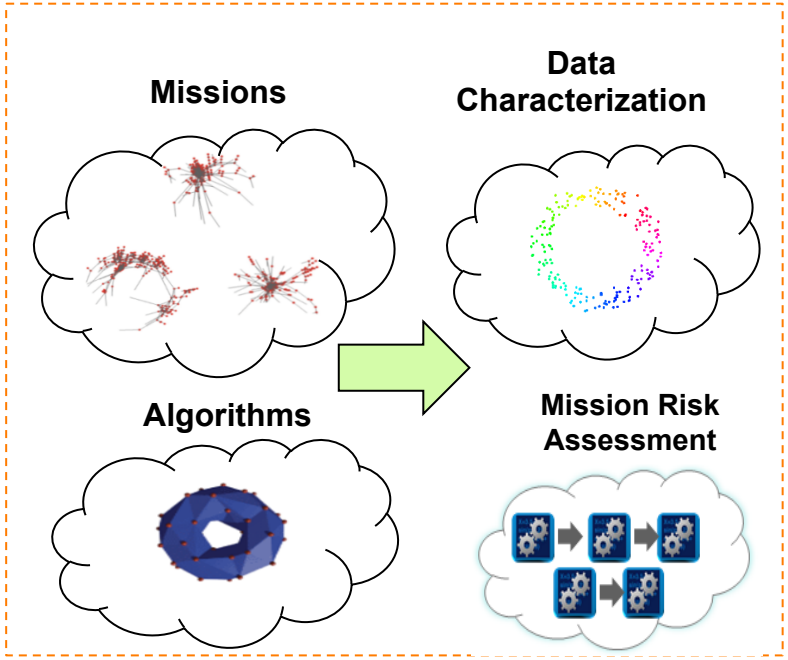
Text Analytics

Imagery Analytics

New Algorithm Research



Transitionable Components



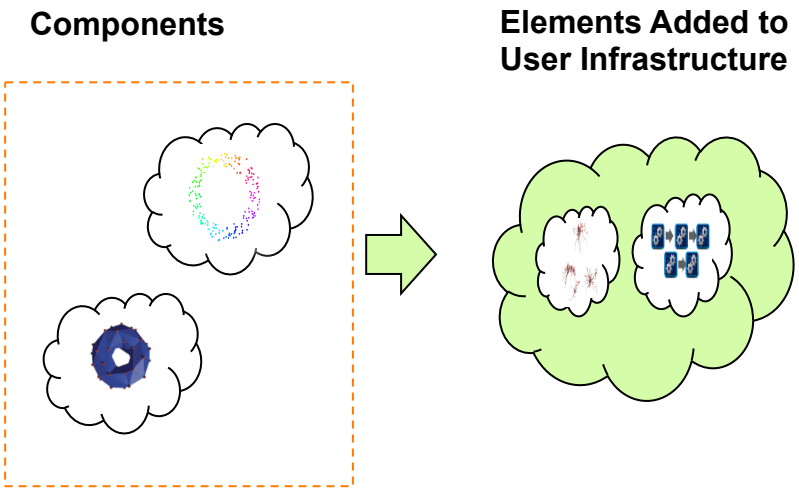
Same Components Provide Assessment For Multiple Customer Missions

Transition Models

Models can either be added to existing infrastructure or used by existing infrastructure as diagnostics for performance

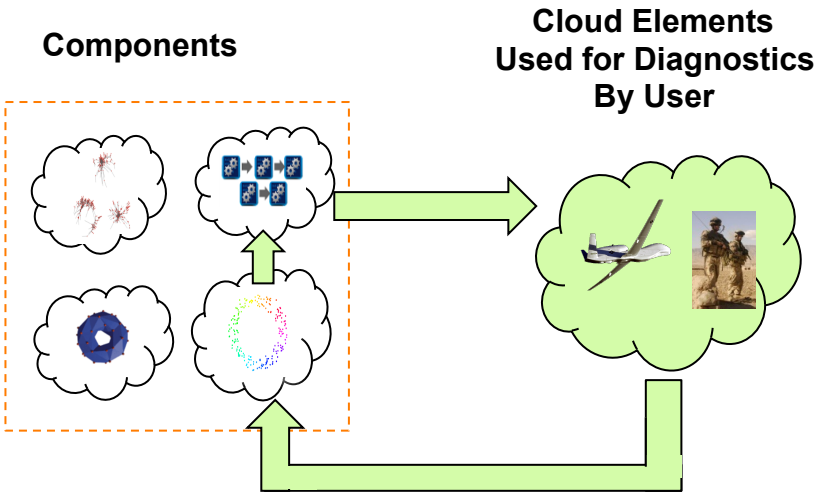
Model 1

(direct integration of components)



Model 2

(user integrates remote elements for their analysis)



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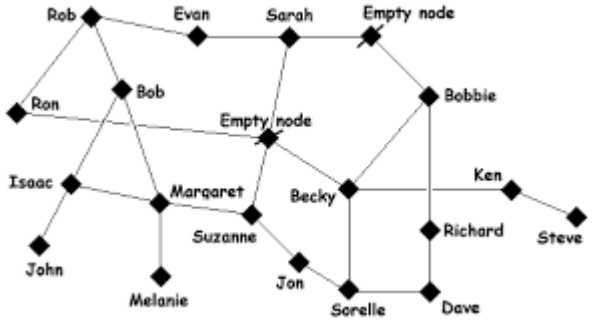
Mission and Data Set Components

Standard threat or mission graphs and the associated data needed to assess a particular threat are available for baseline assessment and design of future missions analysis

Standard Mission Graphs

Scenario Graph Specifies What Data Should Be Collected



Standard Data Sets

Standard Data Sets Specify Ground Truth for Different Data Types & Provenance of Relevant Data

Imagery Truth Data

Text Analytic Data

Algorithm and Mission Risk Component

The algorithm and mission risk components can calculate

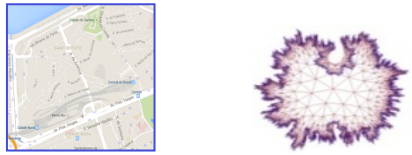
- **Provenance and risk of data + algorithm conclusion**
- **Timeline for output at given data risk level**
- **Overall mission risk and certainty of conclusion**

Algorithms Data Base

Algorithms data base specifies risk incurred for different data types and fidelities and processing time required for actionable information over a given architecture.

Assessment of text algorithm

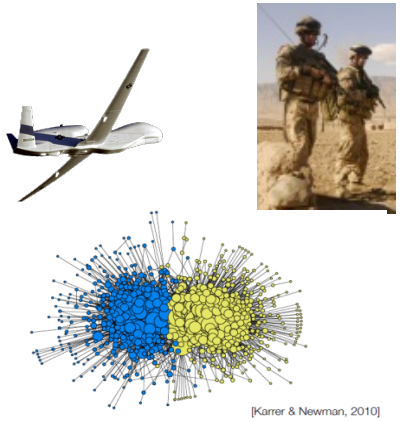
Assessment of track algorithm



Mission Risk Analysis

Database of algorithm conclusions against different scenarios with specified truth data.

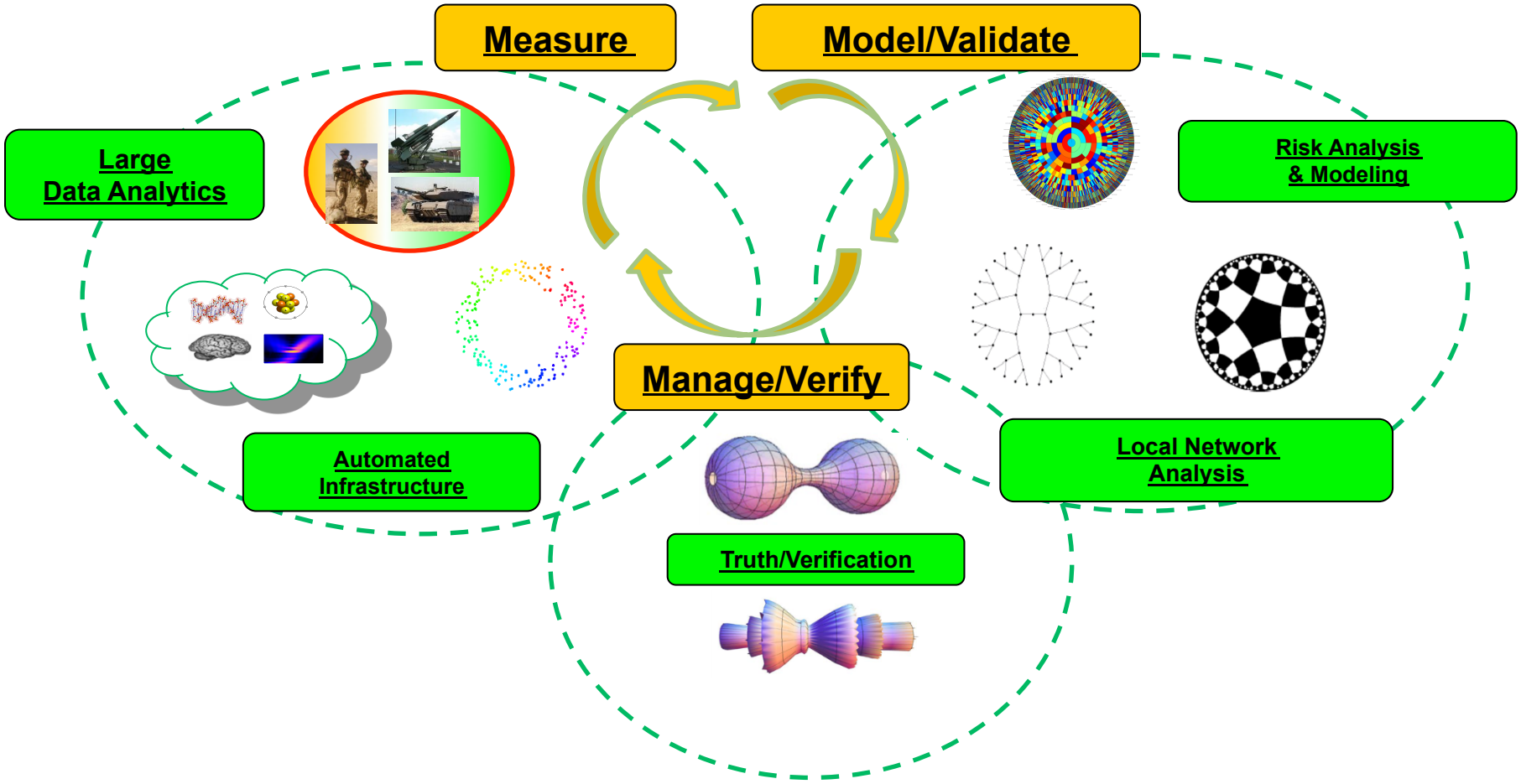
Overall risk to mission with truth



[Karrer & Newman, 2010]

Measure/Model/Manage

Integrated modeling, validation, verification, and management can characterize mission performance with advanced data models



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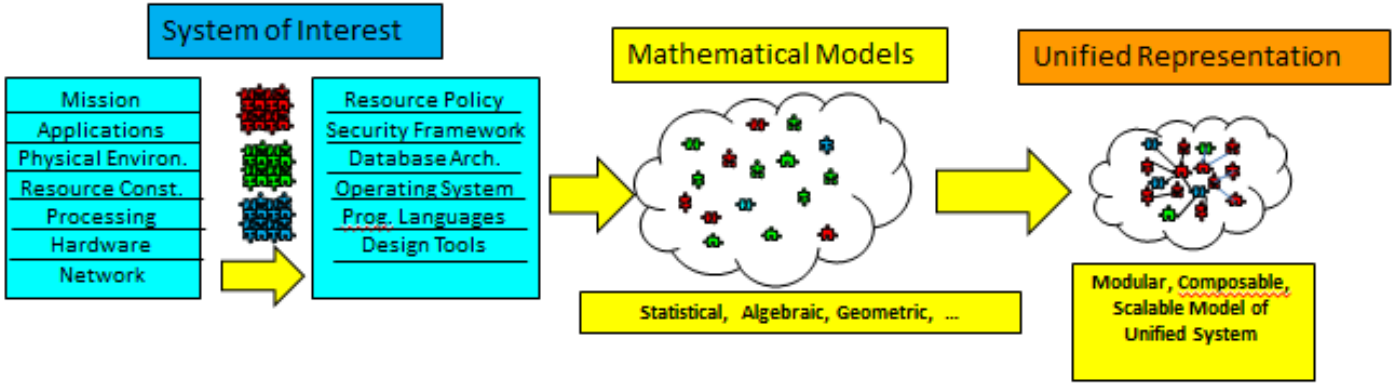
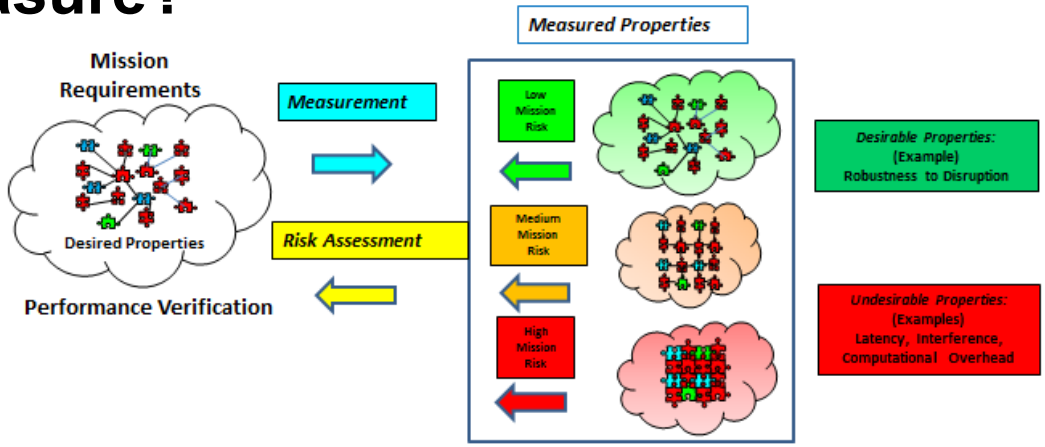
Measurement

We wish to understand how to measure the state of a mission on an infrastructure

What to measure?



How to measure?



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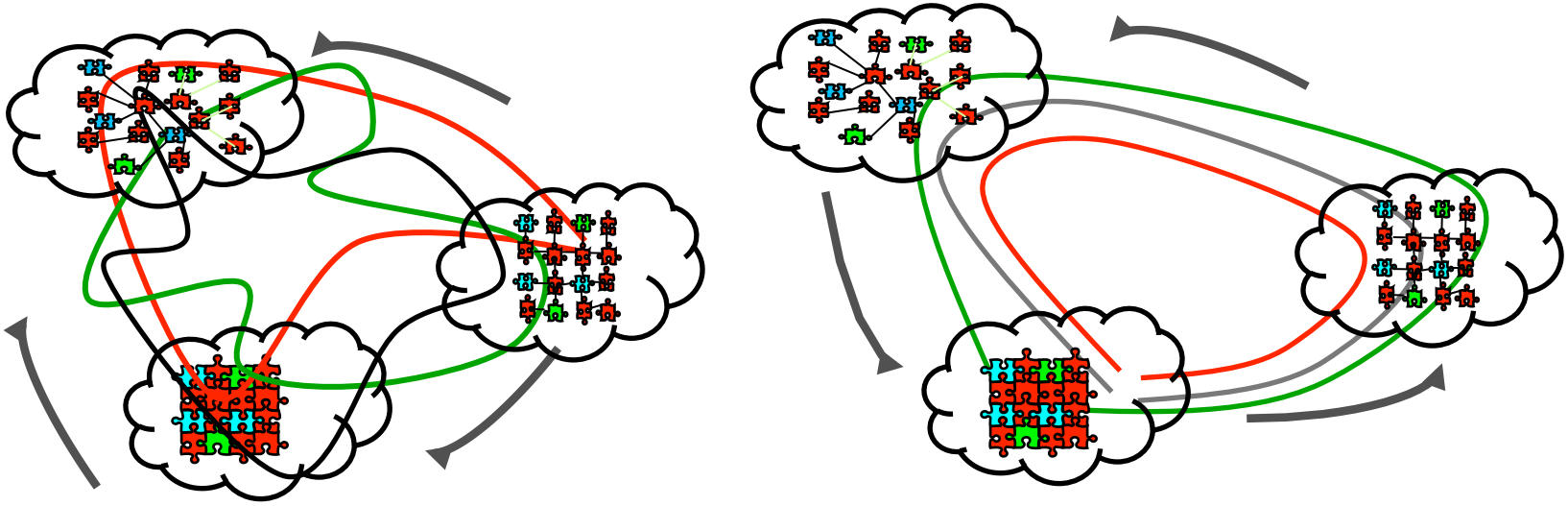
Modeling

We must have validated models of mission performance whic can come from known models or empirical data

Mission Operation Trade-space



Un-validated Modalities (high mission risk)

Validated Modalities (low mission risk)

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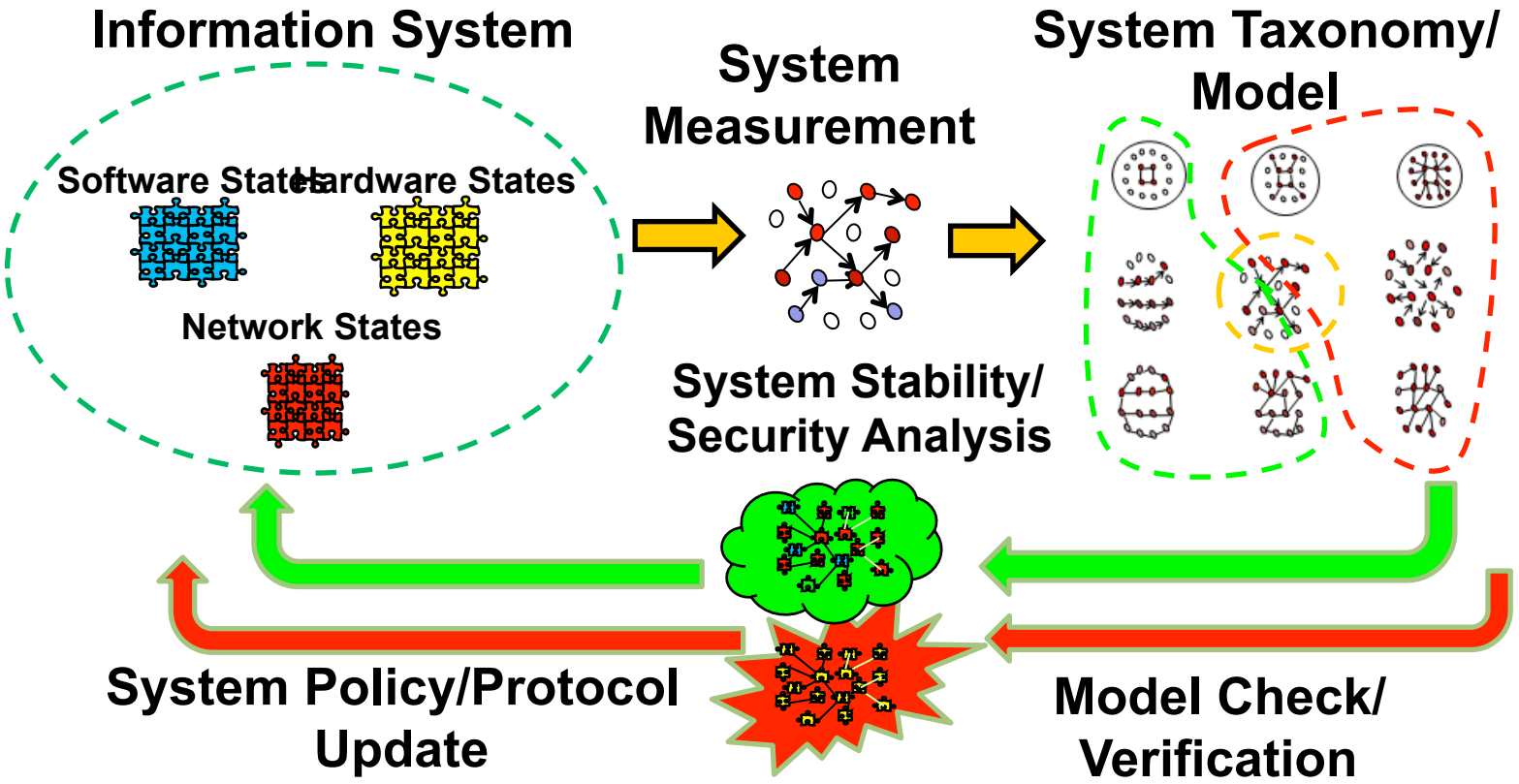
Management

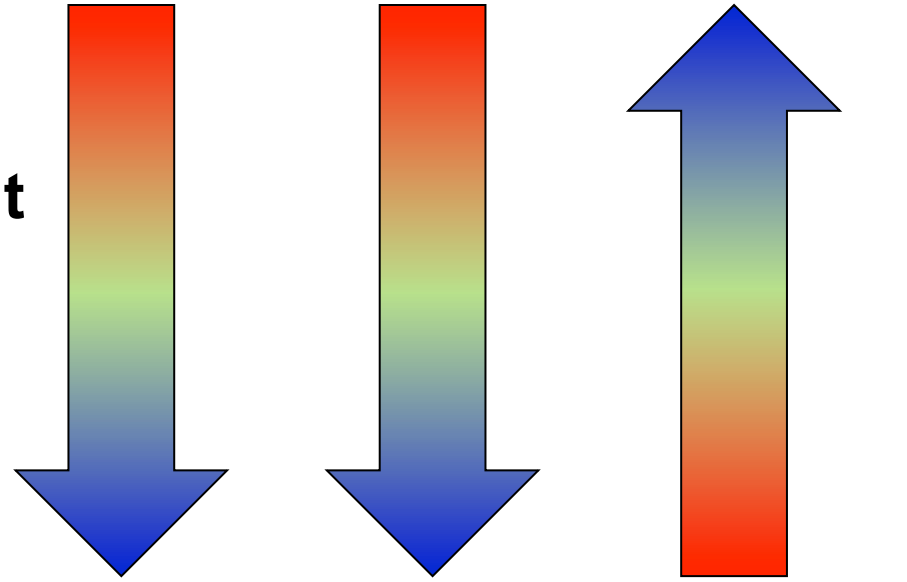
How do we close the loop at multiple architectural layers to assure mission performance and verify system policy/protocol is working?



Metrics of Performance

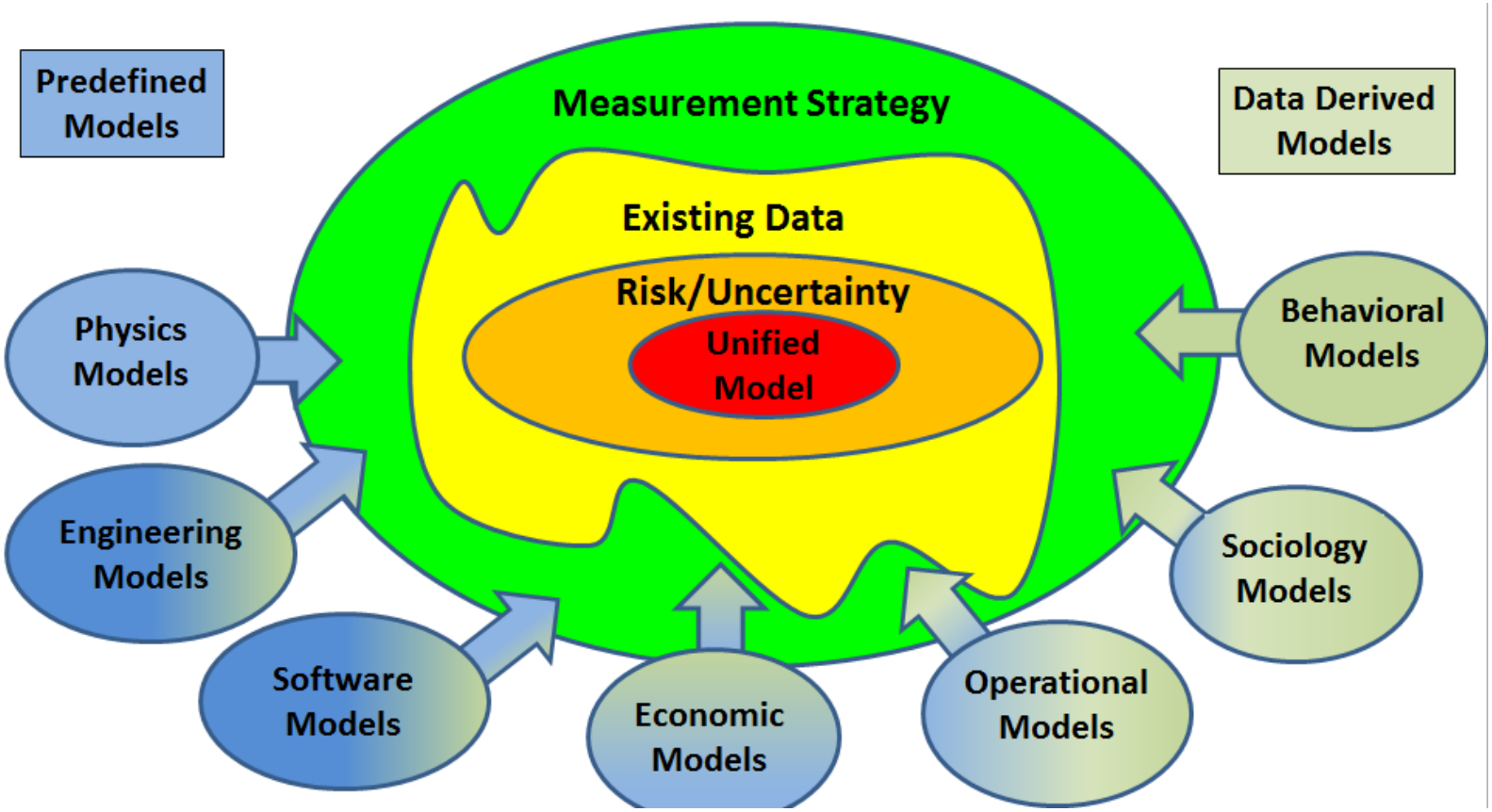
Metrics of performance allow timelines, tracking, and mission performance to be rigorously assessed analyst/commander in real time.

Example Metrics	Desired Outcome
Timeline Reduction	Analysis Time
Rigorous Mission Threat/Risk Assessment	Mission Risk
Rigorous Data Product Confidence Analysis	Data Product Confidence



Risk Analysis and Modeling

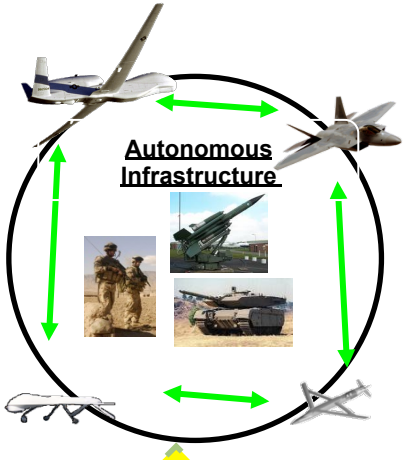
Unified methods for data modeling require a rigorous risk assessment in order to assure commanders, analysts, and system operators of performance.



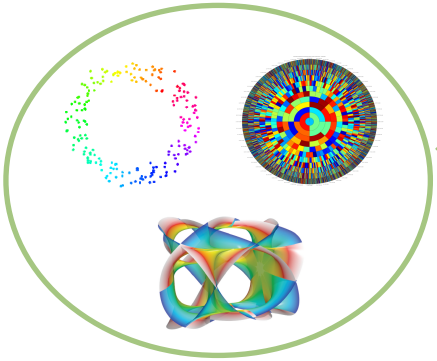
Risk and Autonomy

For automated system performance to be trusted and effective, a strategy for autonomy that enables the lowest mission risk in balancing human workload with automation should be followed

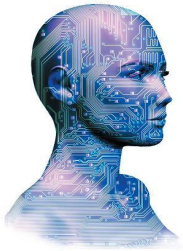
Partially Autonomous Infrastructure



Real Time Data Analytics



Human Modeling & Sensing



- Natural Language
- User Applications
- Physical Environ.
- Resource Const.
- Cultural Influence
- Social Media
- Social Network

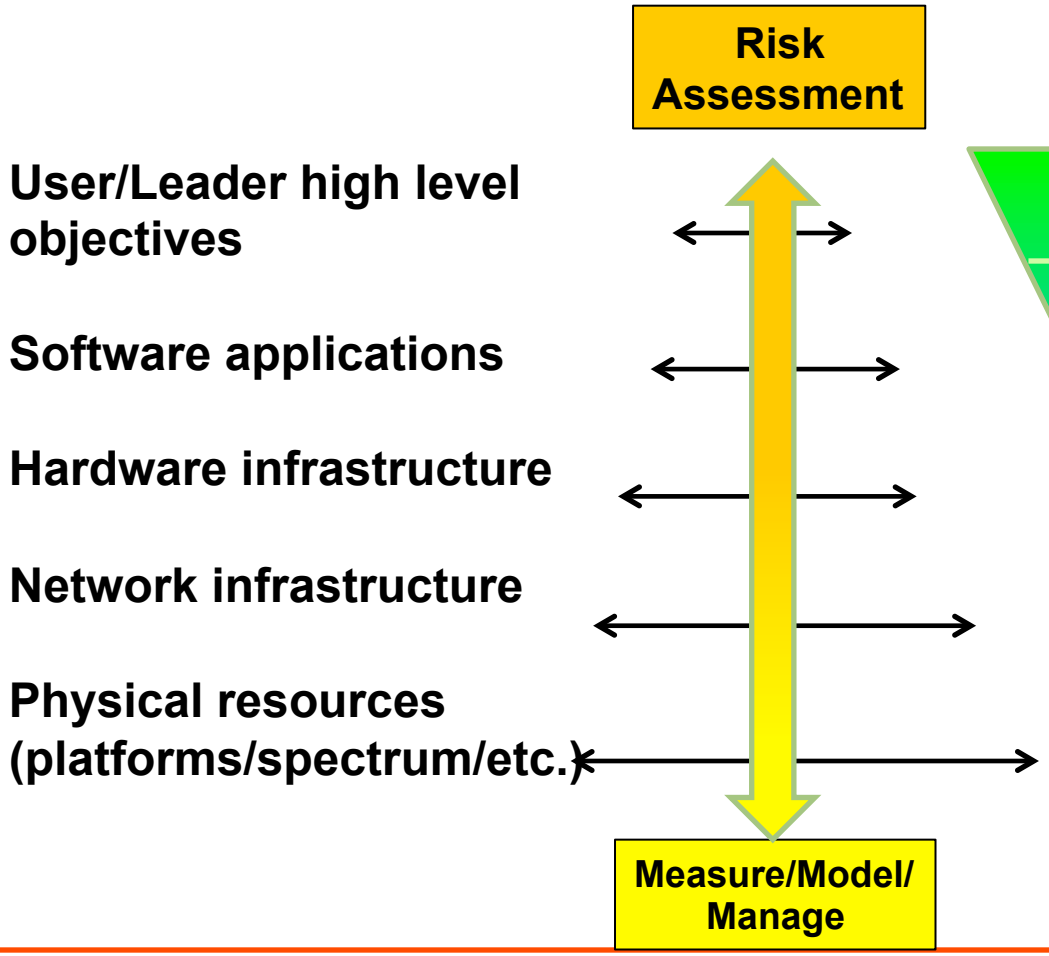
Machine Lower Mission Risk

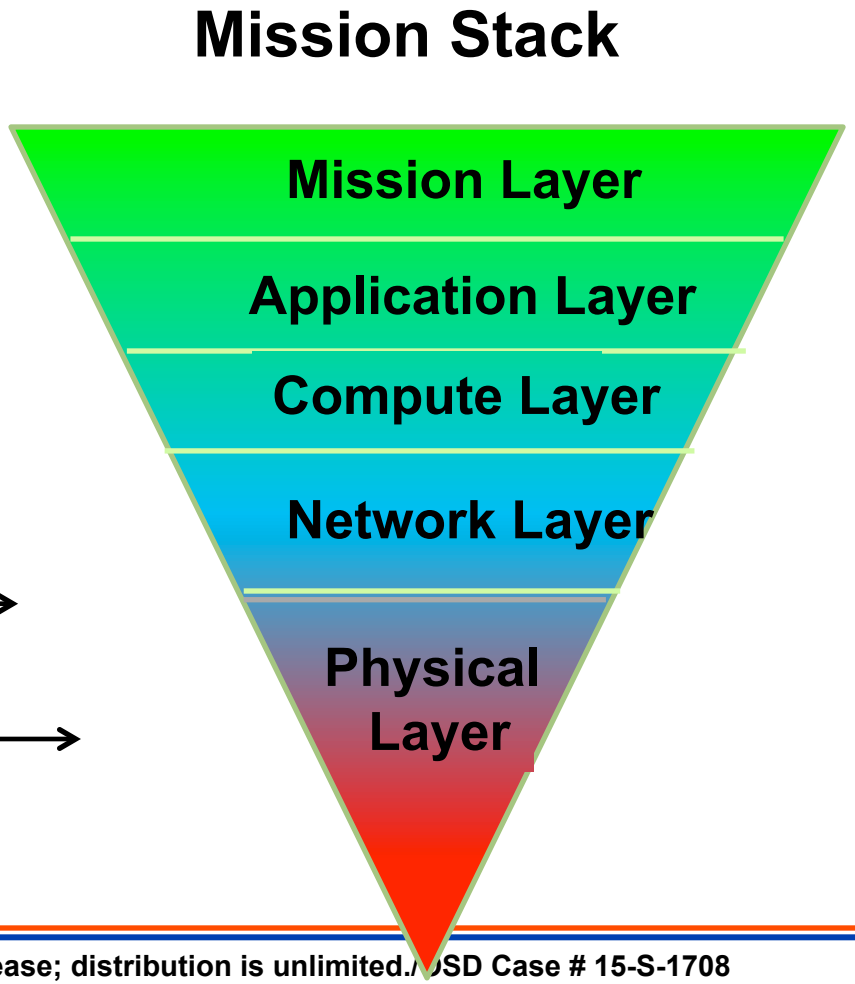
Online Mission Risk Analysis

Human Lower Mission Risk

Mission Stack

Measurement, modeling, and management of mission stack must have rigorous performance and risk metrics associated with them

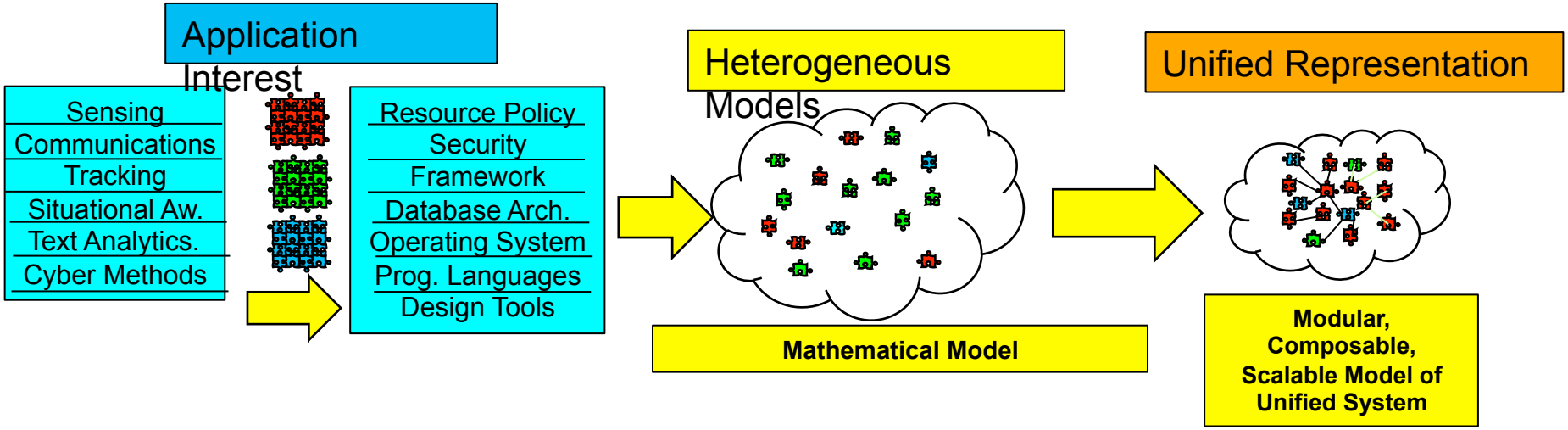




Application Layer

The mission layer may be made up of multiple applications such as sensing, communication, tracking, situational awareness, command and control, etc.

-These methods must be integrated with one unified representation for validation and verification.



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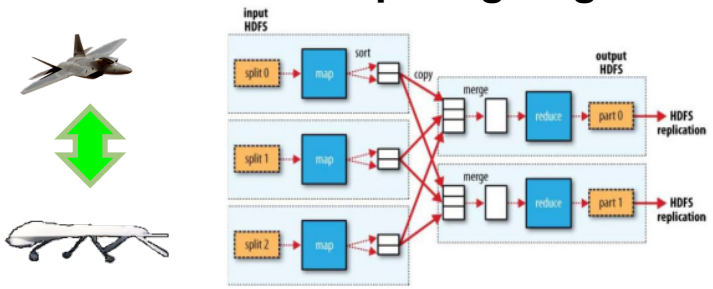
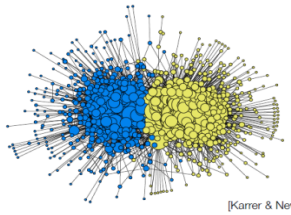
Compute Layer

Current computational infrastructures (cloud resources) are currently high distributed and resource allocation is static. Making this process more dynamic will resilient system performance.

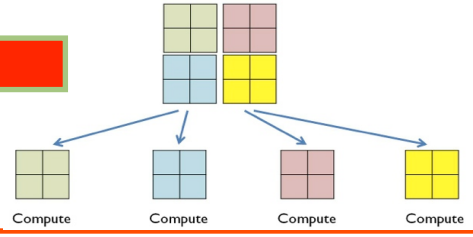
Critical DOD Apps on MAP-Reduce Cloud Computing Engine



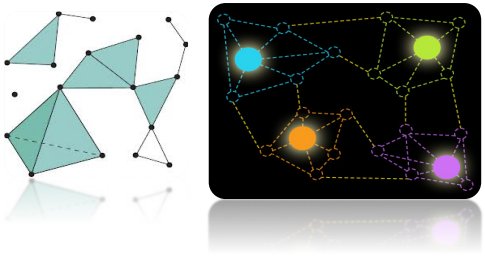
Measurement Based Graph Analytics


[Karrer & Newman, 2010]

Computed System State Representation

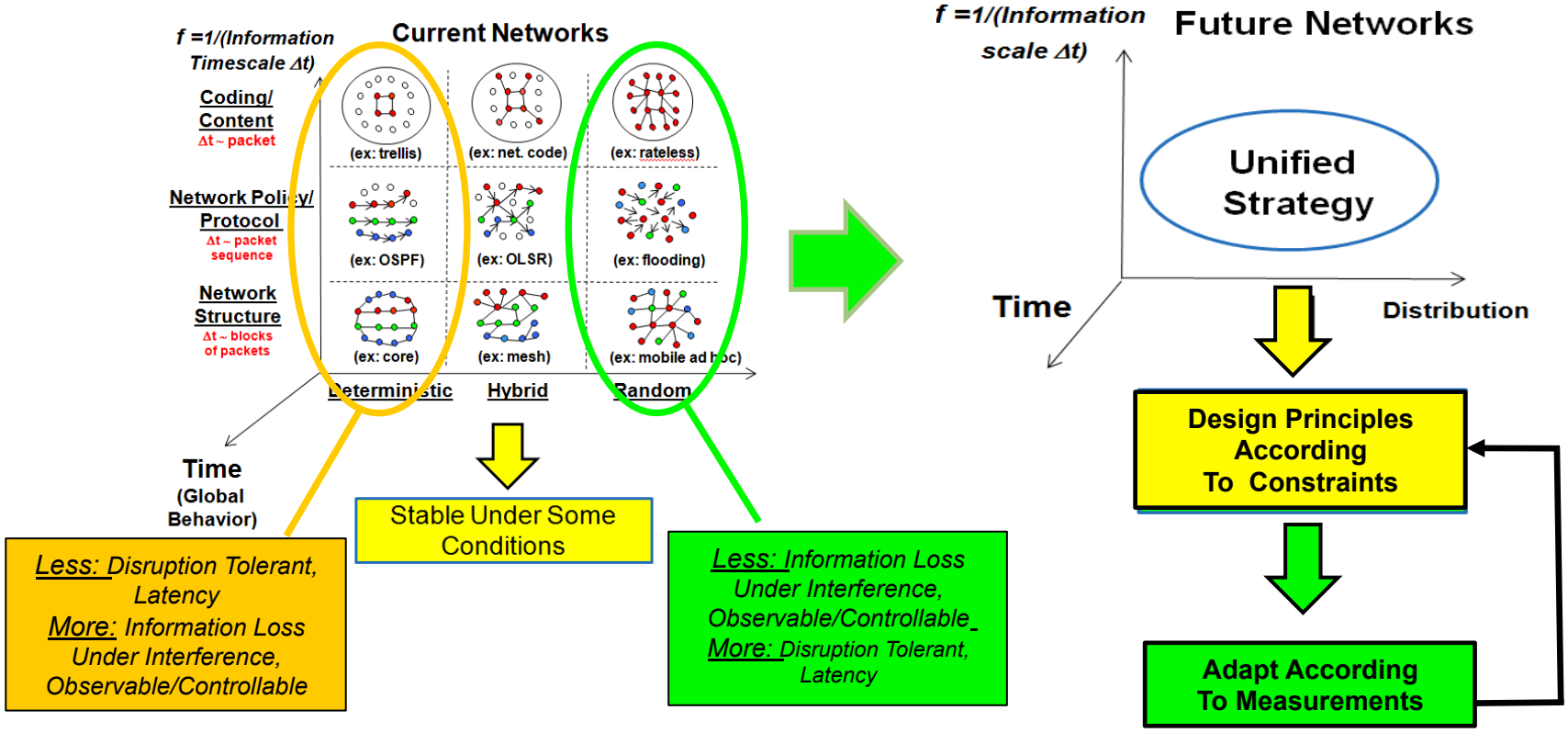


System Performance Verification



Network Layer

Advances such as software defined networks are changing stove piped network management to a heterogeneous management problem which requires dynamic assessment

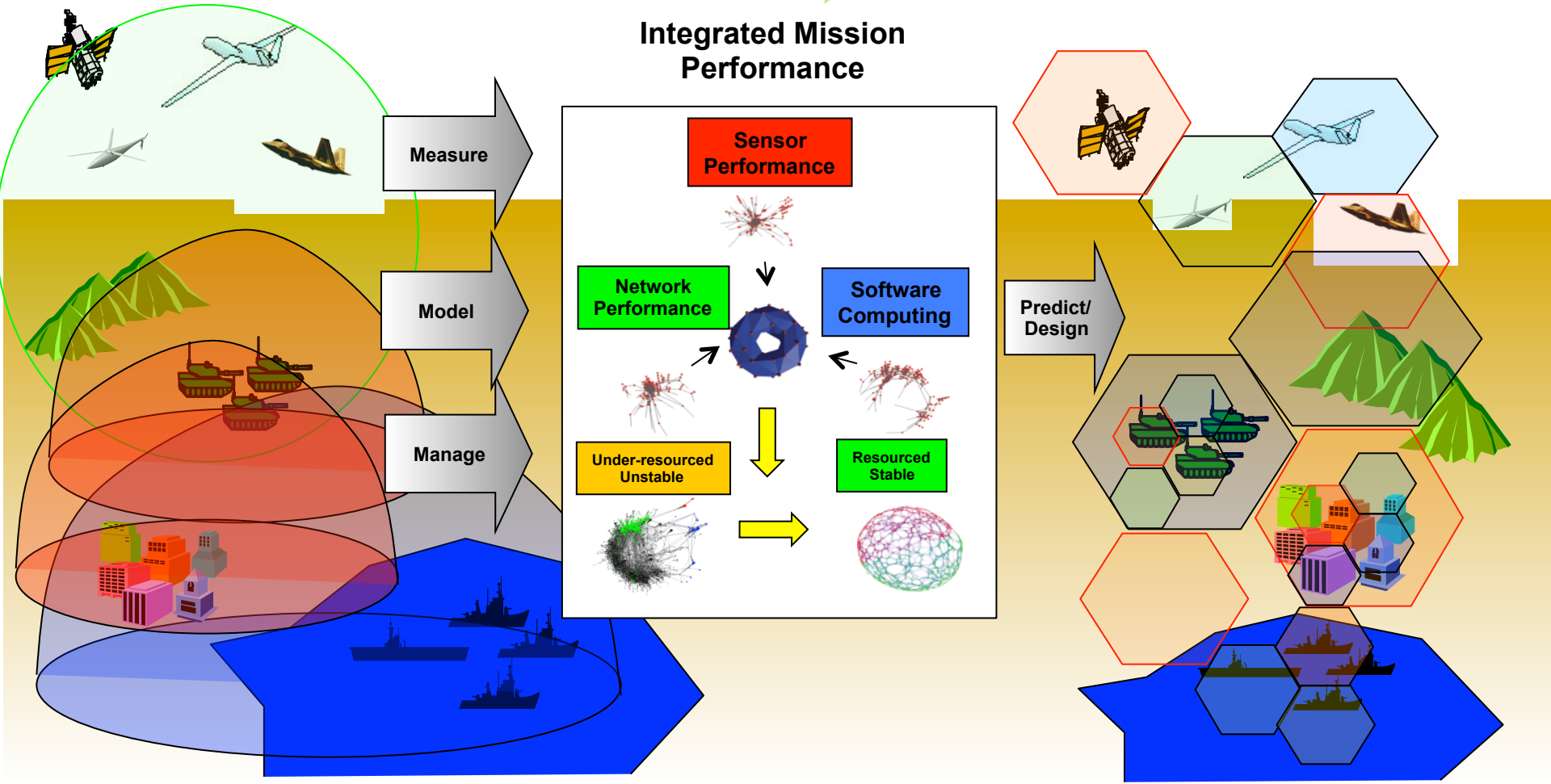


Physical Layer

Commercial pressure on spectrum is changing the static and highly segregated assumptions about physical layer performance.

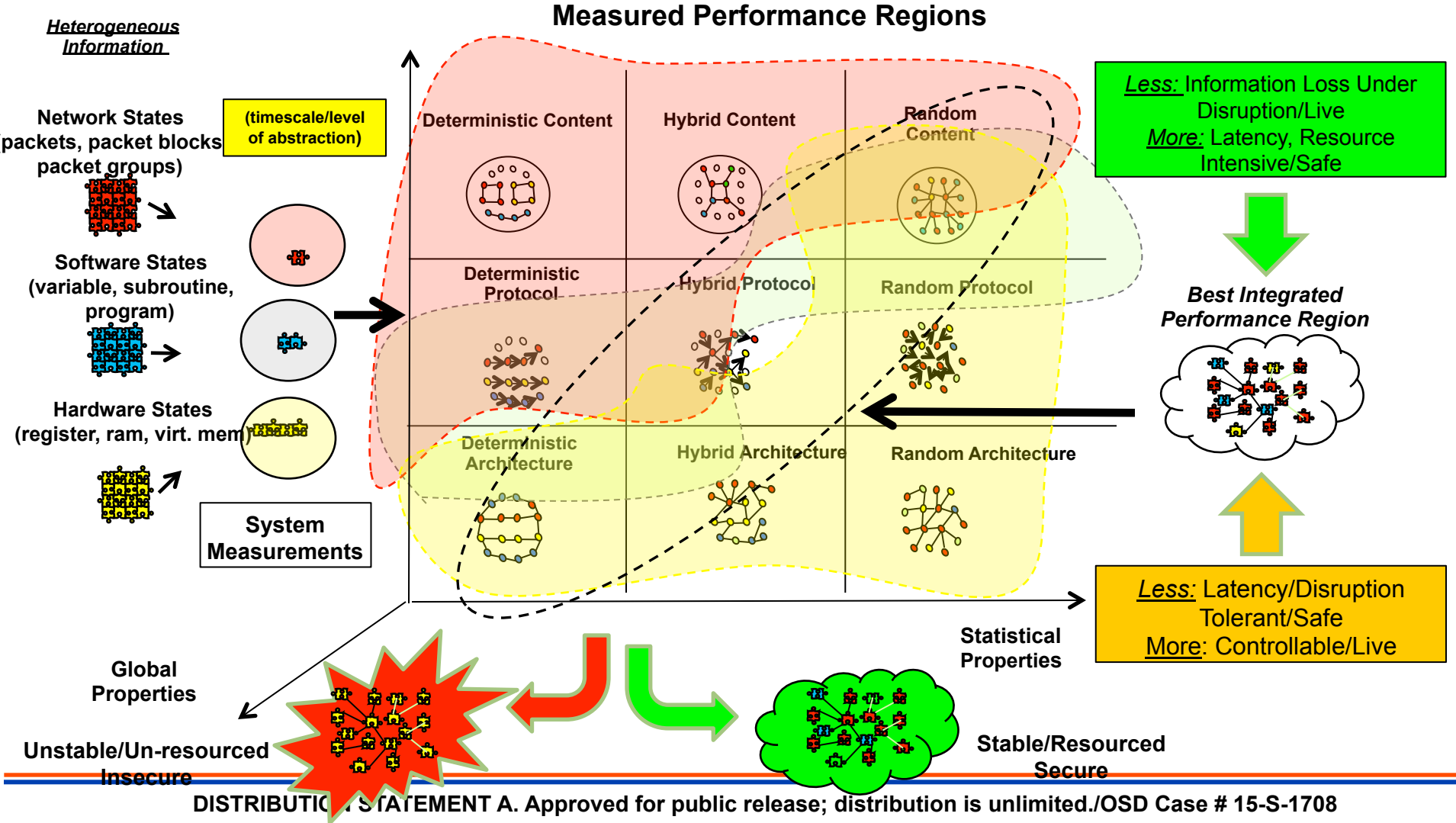
Current State – Static/stove-piped

Future State – Highly coordinated/ & dynamic



Unified Operation

Measure and verify information system properties among various system constraints



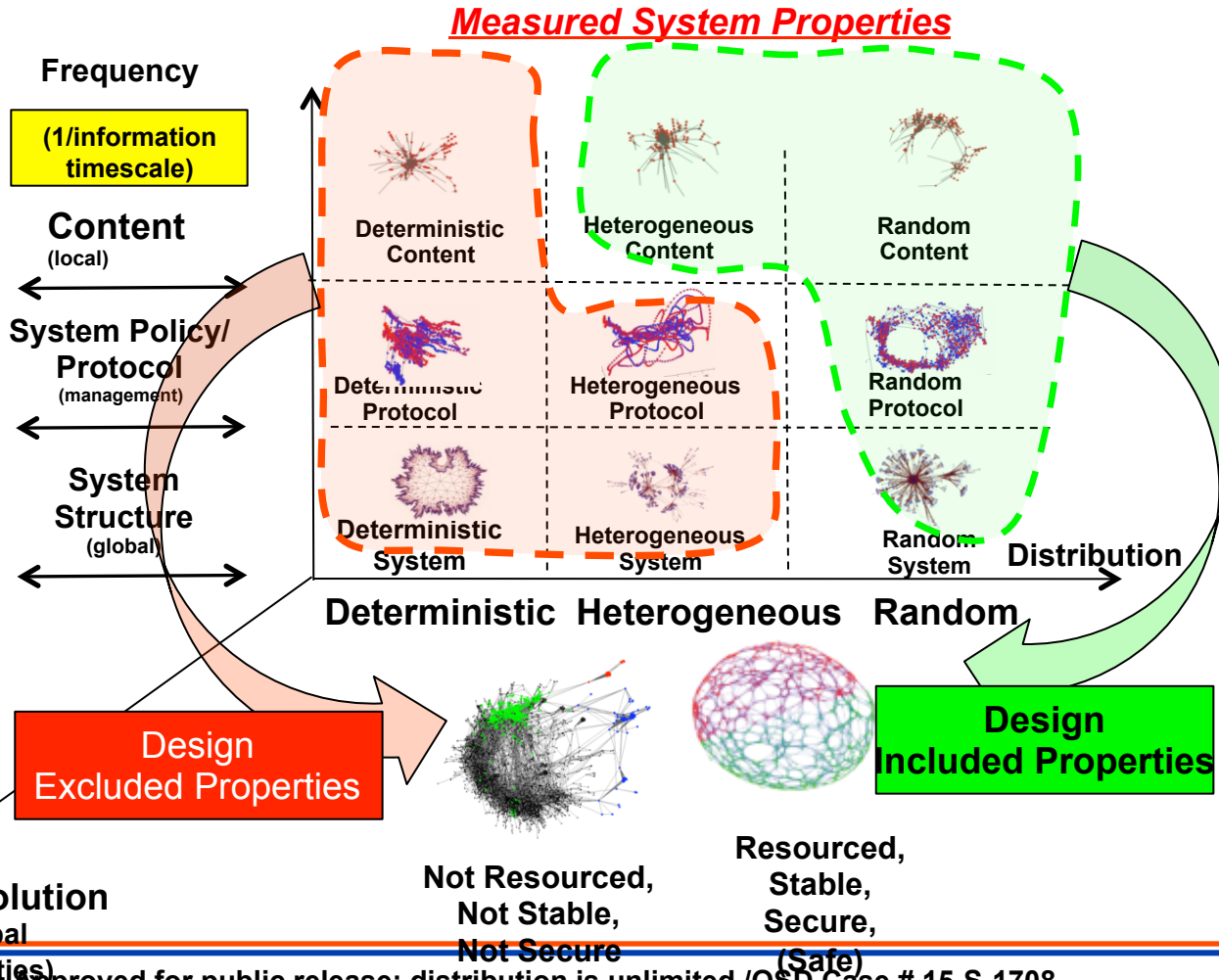
Unified Operation

Units of information translate across heterogeneous domains and can be used to measure and quantify system performance

- Taking this approach can lead to a unified systems and security strategy

Basic Information Unit Scales

Data Network	*Wireless Network*	*Hardware/ Software*	*Social*	*Biological*
Packet	Modulation Unit	Register/ Variable	Words	*DNA*
Packet Groups	Waveform	Ram/ Subroutine	Phrases	Protein Synth.
Packet Blocks	Signal Array	Virtual Mem./ Program	News Reports/ Blogs	Cell Function
		Digital Systems	General Systems	



Current & Future DOD Architectures

An integrated framework to measure, model, and manage mission performance from the application to the physical asset enables to achieve mission performance guarantees in its future infrastructure